Fakultät für Mathematik, Informatik und Physik
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Ankündigung des öffentlichen Vortrags
(„defensio dissertationis“)
im Rahmen der abschließenden kommissionellen Prüfung (Rigorosum)
Doctor of Philosophy"-Doktoratsstudium
Diplomstudium Physik

von

Leitmann Sebastian Constantin

über

“Complex Transport”

Zeit: Dienstag, 25.April 2017, 13.00 Uhr
Ort: Besprechungsraum 2 S 16

Inhalt:

Brownian motion constitutes one of the fundamental processes of particle transport and it is an omnipresent phenomenon in systems of soft-condensed matter. In this work, we consider two extensions of this well established phenomenon. First, we include an external force and monitor its influence on the random motion. As a starting point, we use a lattice model of a tracer driven by an external force in a crowded environment of fixed and hard obstacles. The force on the tracer is switched on at time zero when the system is in equilibrium and we solve analytically for the complete time-dependent response of the tracer exact in first order of the obstacle density and for arbitrarily strong driving. The complex interplay between the obstacle disorder and the external driving is observed in the velocity and the fluctuations of the tracer along the force leading to the emergence of nonanalytic contributions, superdiffusive behavior and fragile long-time tails.
In the second extension, we are concerned with the transport properties of solutions of stiff fibers in the highly entangled regime. In this regime, every fiber is restricted to a tube-like region due to the neighboring needles leading to a strong suppression of the transport properties as anticipated by the tube-concept of Doi and Edwards. We use computer simulations and approximate the stiff fibers by infinitely thin needles performing anisotropic Brownian motion. We show that the dynamics of a needle in the highly entangled regime and on coarse-grained time and length scales can be described by a single needle with the transport coefficients of the needle in solution as predicted by the tube concept. Furthermore, we observe the characteristic algebraic decay in the intermediate scattering function as a fingerprint of the sliding motion of the needle within the tube.

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